

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
REQUEST FOR FILING NATIONAL PHASE OF
PCT APPLICATION UNDER 35 U.S.C. 371 AND 37 CFR 1.494 OR 1.495To: Asst. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

(Our Deposit Account No. 03-3975)

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)Atty Dkt: PM 266020 /T298025US/PYK
M# /Client Ref.

From: Pillsbury Madison & Sutro LLP, IP Group:

Date: February 4, 2000

This is a **REQUEST** for FILING a PCT/USA National Phase Application based on:

- | | | |
|------------------------------|------------------------------|-----------------------------------|
| 1. International Application | 2. International Filing Date | 3. Earliest Priority Date Claimed |
| PCT/FI99/00500 | 9 June 1999 | 12 June 1998 |
| country code | Day MONTH Year | Day MONTH Year |
- (use item 2 if no earlier priority)
4. Measured from the earliest priority date in item 3, this PCT/USA National Phase Application Request is being filed within:

(a) ☒ 20 months from above item 3 date (b) ☐ 30 months from above item 3 date,(c) Therefore, the due date (unextendable) is February 12, 20005. Title of Invention METHOD OF SENDING TIME SLOTS IN BASE STATION SYSTEM AND SUCH A SYSTEM6. Inventor(s) REPONEN, Kari

Applicant herewith submits the following under 35 U.S.C. 371 to effect filing:

7. ☒ Please immediately start national examination procedures (35 U.S.C. 371 (f)).
8. ☐ A copy of the International Application as filed (35 U.S.C. 371(c)(2)) is transmitted herewith (file if in English but, if in foreign language, file only if not transmitted to PTO by the International Bureau) including:
- a. ☐ Request;
- b. ☐ Abstract;
- c. _____ pgs. Spec. and Claims;
- d. _____ sheet(s) Drawing which are ☐ informal ☐ formal of size ☐ A4 ☐ 11"
9. ☒ A copy of the International Application has been transmitted by the International Bureau.
10. A translation of the International Application into English (35 U.S.C. 371(c)(2))
- a. ☒ is transmitted herewith including: (1) ☐ Request; (2) ☒ Abstract;
- (3) 15 pgs. Spec. and Claims;
- (4) 7 sheet(s) Drawing which are:
- ☐ informal ☒ formal of size ☒ A4 ☐ 11"
- b. ☐ is not required, as the application was filed in English.
- c. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.
- d. ☐ Translation verification attached (not required now).

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430 Rec'd PCT/PTO 04 FEB 2000

11. ☒ **PLEASE AMEND** the specification before its first line by inserting as a separate paragraph:
 a. ☒ --This application is the national phase of international application PCT/FI99/00500 filed June 9, 1999 which designated the U.S.--
 b. ☐ --This application also claims the benefit of U.S. Provisional Application No. 60/____, filed ____--
12. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., **before 18th month from first priority date above in item 3, are transmitted herewith (file only if in English) including:**
13. ☒ PCT Article 19 claim amendments (if any) have been transmitted by the International Bureau
14. ☐ Translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., of claim amendments made before 18th month, is attached (required by 20th month from the date in item 3 if box 4(a) above is X'd, or 30th month if box 4(b) is X'd, or else amendments will be considered canceled).
15. **A declaration of the inventor** (35 U.S.C. 371(c)(4))
 a. ☒ is submitted herewith ☒ Original ☐ Facsimile/Copy
 b. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.
16. **An International Search Report (ISR):**
 a. Was prepared by ☐ European Patent Office ☐ Japanese Patent Office ☒ Other
 b. ☒ has been transmitted by the international Bureau to PTO.
 c. ☒ copy herewith (1 pg(s).) ☒ plus Annex of family members (1 pg(s)).
17. **International Preliminary Examination Report (IPER):**
 a. ☒ has been transmitted (if this letter is filed after 28 months from date in item 3) in English by the International Bureau with Annexes (if any) in original language.
 b. ☐ copy herewith in English.
 c.1 ☐ IPER Annex(es) in original language ("Annexes" are amendments made to claims/spec/drawings during Examination) including attached amended:
 c.2 ☐ Specification/claim pages # ____ claims # ____
 Dwg Sheets # ____
 d. ☐ Translation of Annex(es) to IPER (required by 30th month due date, or else annexed amendments will be considered canceled).
18. **Information Disclosure Statement** including:
 a. ☒ Attached Form PTO-1449 listing documents
 b. ☒ Attached copies of documents listed on Form PTO-1449
 c. ☐ A concise explanation of relevance of ISR references is given in the ISR.
19. ☒ **Assignment** document and Cover Sheet for recording are attached. Please mail the recorded assignment document back to the person whose signature, name and address appear at the end of this letter.
20. ☐ Copy of Power to IA agent.
21. ☐ **Drawings** (complete only if 8d or 10a(4) not completed): ____ sheet(s) per set: ☐ 1 set informal; ☐ Formal of size ☐ A4 ☐ 11"
22. ☐ ____ (No.) **Verified Statement(s)** establishing "small entity" status under Rules 9 & 27
23. **Priority** is hereby claimed under 35 U.S.C. 119/365 based on the priority claim and the certified copy, both filed in the International Application during the international stage based on the filing in (country) FINLAND of:
 Application No. 981372 Filing Date June 12, 1998 (2) Application No. _____ Filing Date _____
 (3) _____ (4) _____
 (5) _____ (6) _____
- a. ☒ See Form PCT/IB/304 sent to US/DO with copy of priority documents. If copy has not been received, please proceed promptly to obtain same from the IB.
 b. ☐ Copy of Form PCT/IB/304 attached.

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24. Attached:

25. Preliminary Amendment:

25.5 Per Item 17.c2, **cancel original** pages # _____, claims # _____, Drawing Sheets # _____26. **Calculation of the U.S. National Fee (35 U.S.C. 371 (c)(1)) and other fees is as follows:**Based on amended claim(s) per above item(s) ☐ 12, ☐ 14, ☐ 17, ☐ 25, ☐ 25.5 (hille)

Total Effective Claims	18	minus 20 =	0	x \$18/\$9	= \$0	966/967
Independent Claims	2	minus 3 =	0	x \$78/\$39	= \$0	964/965
If any proper (ignore improper) Multiple Dependent claim is present,				add \$260/\$130	+0	968/969

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4)): →→→ **BASIC FEE REQUIRED, NOW** →→→→A. If country code letters in item 1 are **not** "US", "BR", "BB", "TT", "MX", "IL", "NZ", "IN" or "ZA" ↓

See item 16 re:

1. Search Report was <u>not prepared</u> by EPO or JPO -----	add \$970/\$485	960/961
2. Search Report was prepared by EPO or JPO -----	add \$840/\$420	970/971
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SKIP B, C, D AND E UNLESS country code letters in item 1 are "US", "BR", "BB", "TT", "MX", "IL", "NZ", "IN" or "ZA" ↓

→ <input type="checkbox"/> B. If <u>USPTO</u> did not issue <u>both</u> International Search Report (ISR) <u>and</u> (if box 4(b) above is X'd) the International Examination Report (IPER), -----	add \$970/\$485	+0	960/961
(X) (only) (one) (of) → <input type="checkbox"/> C. If <u>USPTO</u> issued ISR but not IPER (or box 4(a) above is X'd), -----	add \$690/\$345	+0	958/959
(these) (4) → <input type="checkbox"/> D. If <u>USPTO</u> issued IPER but IPER Sec. V boxes <u>not all</u> 3 YES, -----	add \$670/\$335	+0	956/957
→ <input type="checkbox"/> E. If international preliminary examination fee was paid to <u>USPTO</u> and Rules 492(a)(4) and 496(b) <u>satisfied</u> (IPER Sec. V <u>all</u> 3 boxes YES for <u>all</u> claims), -----	add \$96/\$48	+0	962/963

27. **SUBTOTAL =** \$97028. If Assignment box 19 above is X'd, add Assignment Recording fee of ----\$40 +40 (581)29. Attached is a check to cover the ----- **TOTAL FEES** \$1010

Our Deposit Account No. 03-3975

Our Order No. 60256

266020

C#

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CHARGE STATEMENT: The Commissioner is hereby authorized to charge any fee specifically authorized hereafter, or any missing or insufficient fee(s) filed, or asserted to be filed, or which should have been filed herewith or concerning any paper filed hereafter, and which may be required under Rules 15-18 and 492 (missing or insufficient fee only) now or hereafter relative to this application and the resulting Official document under Rule 20, or credit any overpayment, to our Account/Order Nos. shown above for which purpose a duplicate copy of this sheet is attached.

This CHARGE STATEMENT **does not authorize** charge of the issue fee until/unless an issue fee transmittal form is filedPillsbury Madison & Suto LLP
Intellectual Property Group

1100 New York Avenue, NW
Ninth Floor
Washington, DC 20005-3918
Tel: (202) 861-3000
Atty/Sec: BS/mhn

By Atty: Brian SiritzkyReg. No. 37497Sig: [Signature]

Fax: (202) 822-0944
Tel: (202) 861-3702

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APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. PM
266020/T298025US/PYK/KOP
(M#)

Invention: METHOD OF SENDING TIME SLOTS IN BASE STATION SYSTEM AND SUCH A SYSTEM

Inventor (s): REPONEN, Kari

Pillsbury Madison & Sutro LLP
Intellectual Property Group
1100 New York Avenue, NW
Ninth Floor
Washington, DC 20005-3918
Attorneys
Telephone: (202) 861-3000

This is a:

- ☐ Provisional Application
☐ Regular Utility Application
☐ Continuing Application
☒ PCT National Phase Application
☐ Design Application
☐ Reissue Application
☐ Plant Application
☐ Substitute Specification

Sub. Spec Filed _____
in App. No. / _____

SPECIFICATION

**METHOD OF SENDING TIME SLOTS IN BASE STATION SYSTEM AND
SUCH A SYSTEM**

FIELD OF THE INVENTION

The invention relates to a method of transmitting time slots in a base station system.

5 BACKGROUND OF THE INVENTION

Time slots are transmitted as a radio signal to a receiver's subscriber terminal over a radio path via a base station system of a cellular radio network. International standardization authorities, for instance the European Telecommunications Standards Institute ETSI, have defined the specifications
10 a base station system should use. The specifications cover, for example, transceivers of a base station included in a base station system. Power consumption, operating life, average time between faults, operating temperatures, etc., for example, have been specified for the transceivers.

A vast majority of time slots are usually transmitted at a normal
15 transmission power. A normal transmission power refers to a predetermined power range. A subscriber terminal can direct a base station to increase or decrease the transmission power used based on estimations of the reception power. Power control aims to optimize the ratio between radio transmission quality and interference caused by the radio transmission to other users. Usually,
20 the aim is sufficiently high quality with the lowest possible interference.

Certain time slots, for example a time slot comprising a control channel, can be transmitted at a constant power higher than a normal transmission power. The power must be constant so that the subscriber terminal can perform measurements of a neighboring base station enabling handover.
25 The power is higher than normal in order to enable the control channels to be better received. Also other special channels, for example time slots comprising packet switched data or circuit switched data, can be transmitted at a power higher than normal in order to achieve better coverage. In the General Packet Radio Service GPRS of the GSM, for example, light or even non-existent convolution coding is used for channel coding, in which case the transmission
30 power has to be higher in order to guarantee the transmission to reach its destination. In the Enhanced Data Rates for GSM Evolution EDGE of the GSM, a Phase Shift Keying 8-PSK selected as the modulation method also requires a better signal-to-noise ratio than a normal GSM modulation method.

A way to improve the signal-to-noise ratio is to use a transmission power higher than normal.

When transmission powers higher than normal are used, it becomes problematic to meet the specifications defined for the base station. This is due to the fact that transmission powers higher than normal cause power consumption higher than normal in the base station; consequently, power sources higher than normal are needed, and, similarly, more extensive back-up batteries also become necessary. When transmission powers higher than normal are used, transceivers also become increasingly heated, which means that more efficient fans are needed. It becomes more difficult to design a radio network because a base station using transmission powers higher than normal is larger than normally, requiring larger power sources. Transceivers using transmission powers higher than normal also suffer more easily from failures owing to the fact that their components become more easily overheated than normally.

It has been estimated that the material and operating costs of a base station increase by as much as 30% when transmission powers twice as high as normal are used. This is due to costlier transceivers, larger power sources, more extensive back-up batteries, more efficient cooling systems, higher renting costs of a base station location, etc.

If the power consumption of a base station could be reduced by half when using transmission powers higher than normal, the base station running temperature would decrease significantly, in which case its operating life could even double or quadruple.

A solution to the heating problem described above is to use a "combiner bypass" structure in the base station. In such a case, time slots usually requiring transmission power higher than normal, time slots comprising control channels, for example, are then bypassed past a combiner since considerable power losses of several decibels take place in the combiner when signals are combined. For instance, when four transceivers using a 10-watt transmission power are combined in the combiner, only a 2.5-watt input transmission power can be generated to an antenna per one transceiver, resulting in a power loss of approximately 6 decibels. The signals directed past the combiner are conveyed to a separate antenna via which the signals are transmitted. Consequently, the time slots usually requiring transmission power higher than normal can now be transmitted at a normal transmission power

since no power loss takes place thanks to the combiner. Because the number of antennas usually is a determining factor for the renting costs of a base station location, the required additional antenna presents the most serious problem of this solution. In a normal base station divided in three sectors the described solution necessitates three additional antennas. Furthermore, the additional antennas cause the wind load of the a mast structure to increase, which means that the mast structure has to be built stronger and, consequently, costlier.

BRIEF DESCRIPTION OF THE INVENTION

10 An object of the invention is thus to provide a method and an apparatus implementing the method such that the above-mentioned problems can be solved. This is achieved with a method of transmitting time slots in a base station system, the method comprising the steps of: defining certain transmission powers as a normal transmission power; determining for each time slot
15 the transmission power to be used. In accordance with the invention, the method is characterized by transmitting time slots to be transmitted at a transmission power higher than normal alternately, using at least two different transceivers in order to minimize heat build-up in the transceivers.

The invention further relates to a base station system comprising: at
20 least two transceivers; a control part for controlling the operation of the transceivers; a switching field for connecting time slots to the transceivers; certain transmission powers being defined as a normal transmission power in the control part; the control part being arranged to determine for each time slot a transmission power to be used. The base station of the invention is characterized in that the control part is arranged to direct the switching field to place
25 time slots to be transmitted at a transmission power higher than normal to be transmitted alternately, using two different transceivers in order to minimize heat build-up in the transceivers.

The preferred embodiments of the invention are disclosed in the
30 dependent claims.

The idea underlying the invention is that time slots requiring transmission powers higher than normal are not continually transmitted via the same transceiver but alternately via different transceivers.

The method and system of the invention provide several advantages. Heat build-up in a single transceiver can be minimized, whereby the
35

above-described problems presented by the heating of the transceiver can be avoided. The transceiver and its power generation and cooling systems can be designed for lower power.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The invention is now described in closer detail in connection with the preferred embodiments with reference to the accompanying drawings, in which

Figure 1 shows an example of the structure of a cellular radio network,

10 Figure 2 shows the structure of a transceiver,

Figure 3 shows a circuit-switched telephone connection,

Figure 4 shows packet transmission,

Figure 5A illustrates the operation of a combiner,

Figure 5B illustrates transceivers using different antennas,

15 Figure 6 shows an example of time slot allocation of the invention to different transceivers,

Figure 7 is a flow diagram of the method steps of the invention.

DETAILED DESCRIPTION OF THE INVENTION

20 The invention can be used in a cellular radio network wherein a signal to be transmitted can be divided into subsignals in the time domain. Referring to Figure 1, a typical structure of a cellular radio network is described. Figure 1 comprises only relevant blocks for describing the invention, but it is obvious to those skilled in the art that a common cellular radio network also comprises other functions and structures which need not be described here.

25 The examples describe a cellular radio network using Time Division Multiple Access TDMA without, however, being restricted thereto.

A cellular radio network typically comprises a fixed network infrastructure, i.e. a network part 128, and subscriber terminals 150, which can be fixedly located, positioned in a vehicle or portable terminals to be carried
30 around. The network part 128 comprises base stations 100. A plurality of base stations 100, in turn, is controlled in a centralized manner by a base station controller 102 connected thereto. The base station 100 comprises transceivers 114. A base station 100 typically comprises 1 to 16 transceivers 114. In the TDMA radio system, for example, one transceiver 114 typically provides one
35 TDMA frame, i.e. 8 time slots, with radio capacity.

The base station 100 comprises a control unit 118 controlling the operation of the transceivers 114 and a multiplexer 116. The multiplexer 116 is used for placing traffic channels and control channels used by the plurality of transceivers 114 over one transmission connection 160.

The transceivers 114 of the base station 100 are connected to an antenna array 112, which implements a bidirectional radio connection 170 to the subscriber terminal 150. In the bidirectional radio connection 170, the structure of frames to be transferred is clearly defined, and it is called an air interface.

Figure 2 shows the structure of one transceiver 114 in closer detail. First, functions during reception are described. A receiver 200 comprises a filter blocking frequencies outside a desired frequency band. Next, the signal is converted to an intermediate frequency or directly to baseband, and the signal in this form is sampled and quantized in an analogue/digital converter 202.

An equalizer 204 compensates for interference caused by multipath propagation, for example. A demodulator 206 draws a bit stream from the equalized signal, the bit stream being conveyed to a demultiplexer 208. The demultiplexer 208 separates a desired part of the bit stream into logical channels. This function is based on the structure of the received bit stream which consists of radio bursts placed in the time slots, the radio bursts forming the physical channel.

A channel codec 216 decodes the bit stream of different logical channels, in other words decides whether the bit stream is signalling information, which is relayed to a control unit 214, or whether the bit stream is speech, which is relayed 240 to a speech codec 122 of the base station controller 102. The channel codec 216 decodes potential channel codings, for example block coding and convolution coding, and deinterleaves potential interleaving, and decrypts the encryption used over a radio path.

The control unit 214 performs internal control tasks by controlling the different units, mainly according to commands received from the base station controller 102.

Next, functions during transmission are described. Data to be transmitted is channel-coded, interleaved and encrypted in the channel codec 216. A burst generator 228 adds a training sequence and a tail to the data supplied from the channel codec 216. A multiplexer 226 indicates the physical channel to each burst. A modulator 224 modulates the digital signals into a

radio frequency carrier wave. Being analogue by nature, this function requires a digital/analogue converter 222.

A transmitter 220 comprises a filter to restrict the bandwidth. In addition, the transmitter 220 controls the output power of the transmission. A synthesizer 212 provides the different units with necessary frequencies. A clock comprised by the synthesizer 212 can be locally controlled or it can be controlled in a centralized manner from somewhere else, for example from the base station controller 102. The synthesizer 212 creates the necessary frequencies by a voltage-controlled oscillator, for example.

In the manner shown in Figure 2, the structure of the transceiver can be further divided into radio frequency parts 230 and a digital signal processor with its software 232. The radio frequency parts 230 comprise the receiver 200, the transmitter 220 and the synthesizer 212. The digital signal processor with its software 232 comprises the equalizer 204, the demodulator 206, the demultiplexer 208, the channel codec 216, the control unit 214, the burst generator 228, the multiplexer 226 and the modulator 224. Converting an analogue radio signal into a digital signal requires the analogue/digital converter 202, and, correspondingly, converting a digital signal into an analogue signal requires the digital/analogue converter 222.

The structure of the subscriber terminal 150 can be represented by utilizing the depiction of the structure of the transceiver 114 in Figure 2. The structural parts of the subscriber terminal 150 are operatively similar to those of the transceiver 114. The subscriber terminal 150 further comprises a duplex filter between the antenna 112 and the receiver 200 and the transmitter 220, the user interface parts and the speech codec. The speech codec is connected to the channel codec 216 via the bus 240.

If the base station 100 employs frequency hopping, it can be implemented in two ways: as base band hopping or synthesizer hopping. If the base station 100 comprises a plurality of transceivers 114, each time slot is transferred to a transceiver 114 operating at a certain base band in accordance with a frequency hopping sequence. If, for example, the base station comprises only one transceiver 114 and frequency hopping is to be implemented, a synthesizer 412 and a transmitter 420 must then be directed to different frequencies in order to transmit each time slot at a frequency according to the frequency hopping sequence.

The base station controller 102 comprises a group switching field 120 and a control unit 124. The group switching field 120 is used for switching speech and data, and for connecting signalling circuits. A base station system 126 comprises the base station 100 and the base station controller 102 further comprises the transcoder 122. Task assignment between the base station controller 102 and the base station 100 and the physical structure thereof may vary according to the implementation. The base station 100 typically serves to implement the radio path in a manner described above. The base station controller 102 typically manages the following tasks: traffic channel configuration, frequency hopping control, subscriber terminal paging, power adjustment, active channel quality control and handover control.

The transcoder 122 is usually located as close to a mobile services switching centre 132 as possible since speech can thus be transmitted in the cellular radio form between the transcoder 122 and the base station controller 102 using as little transmission capacity as possible. The transcoder 122 converts the different digital speech coding forms used between a public telephone network and a radio telephone network into compatible ones with each other, for example from the 64 kbit/s form of the fixed network into another form (for example 13 kbit/s) of the cellular radio network, and vice versa. The control unit 124 performs call control, mobility management, collection of statistical information and signalling.

In the cellular radio network, a packet switched connection can also be used, for example the 2+ phase packet transmission of the GSM system, i.e. General Packet Radio Service GPRS.

As can be seen from Figure 1, the group switching field 120 can be used for providing connections (depicted by black dots) to a Public Switched Telephone Network PSTN 134 via the mobile services switching centre 132 and to a packet transmission network 142. A terminal 136 in the public telephone network 134 is typically a common telephone or an Integrated Services Digital Network ISDN telephone.

Figure 3 shows how a normal circuit-switched telephone connection is set up between the subscriber terminal 150 and the common telephone 136.

Figure 4, in turn, shows how a packet-switched transmission connection is set up. The connection between the packet transmission network 142 and the group switching field 120 is set up by a Serving GPRS Support Node SGSN 140. The support node 140 serves to transfer packets between

the base station system and a Gateway GPRS Support Node GGSN 144, and to keep a record of the subscriber terminal's 150 location in its area.

The gate node 144 connects the public packet transmission network 146 and the packet transmission network 142. The Internet protocol or X.25 protocol can be used on the interface. The gate node 144 hides, by encapsulating, the inner structure of the packet transmission network 142 from the public packet transmission network 146, so the public packet transmission network 146 regards the packet transmission network 142 as a subnetwork, and the public packet transmission network can direct packets to and receive packets from the subscriber terminal 150 located in the packet transmission network 142.

Typically, the packet transmission network 142 is a private network using the Internet protocol and conveying signalling and tunnelled user data. The structure of the network 142 may vary in its architecture and protocols according to the operator below the Internet protocol layer.

The public packet transmission network 146 can be the global Internet network, for example. A terminal 148, a server computer, for example, connected to the Internet network is to transfer packets to the subscriber terminal 150.

On the air interface 170, time slots free from packet switched transmission are used for packet transmission. The capacity for packet transmission is allocated dynamically, in other words when a data transmission request is received, any free channel can be allocated to packet transmission. The arrangement is flexible by nature, circuit-switched connections taking priority over packet-switched connections. When necessary, circuit-switched transmission overrides packet-switched transmission, i.e. a time slot used by packet transmission is allocated to circuit-switched transmission. This is feasible since packet transmission is highly tolerant of such interruptions: the transmission is simply continued by another allocated time slot. The arrangement can also be implemented such that no strict priority is given to circuit-switched transmission but both circuit-switched and packet-switched transmission requests are served in order of reception.

Figure 5A discloses the structure of the base station 100 in closer detail. Time slots used by several different transceivers 114 are thus multiplexed to the same transmission connection at the multiplexer 116. The multiplexer 116 also demultiplexes the time slots. In Figure 5A, two transceivers

114 are divided into their logical parts: a transmitter 500A, 500B and a receiver 506A, 506B. A combiner 502 combines signals of the two different transmitters 500A, 500B to be transmitted via one antenna 112. If the transmission power of the transmitters 500A, 500B is ten watts, for example, after the combiner 502 the power to be conveyed to the antenna is approximately five watts, in other words the power loss in the combiner 502 is approximately three decibels. In addition, a duplex filter 504 is required to separate transmission frequencies from reception frequencies. Correspondingly, a divider 508 is provided on the receiving side to separate signals belonging to the different receivers 506A, 506B from each other.

Figure 5B shows a solution which does not use any combiner 502 at all but the transmitters 500A, 500B have a direct connection to separate antennas 112A, 112B, in which case power loss in the combiner 502 can be avoided.

After having thus described an example of a cellular radio network and its operation with reference to Figures 1, 2, 3, 4, 5A and 5B, a method in accordance with the invention can now be examined with reference to Figure 7. The performance of the method of the invention starts in block 700 and ends in block 708.

In the first actual step 702, certain transmission powers are defined as a normal transmission power. This can be a particular power range, for example, or transmission powers listed from graded transmission powers.

In the second actual step 704, for each time slot a transmission power to be used is determined.

In the third actual step 706, time slots to be transmitted at a transmission power higher than normal are transmitted alternately, using at least two different transceivers in order to minimize heat build-up in the transceivers.

A time slot requiring a transmission power higher than normal can be, for example, a time slot in which is placed a control channel, a packet-switched channel (for example a packet data traffic channel of the GPRS), or a high-speed data channel (for example an EDGE-modulated traffic channel or an EDGE-modulated packet data traffic channel of the GPRS).

In a preferred embodiment, the time slots to be transmitted at a higher transmission power than normal are transmitted alternately, using at least two different antennas, thereby providing the transmission with antenna diversity.

In another preferred embodiment of the invention, time slots to be transmitted at a normal transmission power are transmitted using frequency hopping. This compensates for coverage, i.e. nearly as good coverage is obtained for the frequency-hopping time slots transmitted at a normal transmission power as the time slots transmitted at a higher transmission power than normal have.

Figure 6 illustrates the operation in accordance with step 706. In the example of Figure 6, the base station 100 uses four transceivers 500A, 500B, 500C, 500D. One frame 600A, 600B, 600C, 600D comprising eight time slots 0, 1, 2, 3, 4, 5, 6 and 7 can be transmitted via each transmitter 500A, 500B, 500C, 500D.

A channel is composed of a frequency/time slot combination; therefore, all time slots of the first frame 600A are transmitted at a frequency f1, all time slots of the second frame 600B at a frequency f2, all time slots of the third frame 600C at a frequency f3, and all time slots of the fourth frame at a frequency f4. All time slots 0 to 7 of the first frame 600A are time slots requiring transmission power higher than normal. Normally, without the present invention, said time slots would all be transmitted via the transmitter 500A, which would overheat owing to increased heat build-up.

This is avoided by the method of the invention according to which method time slot 0 of the first frame 600A is transmitted at the frequency f1 by the fourth transmitter 500D, time slot 1 at the frequency f1 by the third transmitter 500C, time slot 2 at the frequency f1 by the second transmitter 500B, time slot 3 at the frequency f1 by the first transmitter 500A, time slot 4 at the frequency f1 by the fourth transmitter 500D, time slot 5 at the frequency f1 by the third transmitter 500C, time slot 6 at the frequency f1 by the second transmitter 500B, and time slot 7 at the frequency f1 by the first transmitter 500A. Hence, heat build-up of the time slots transmitted at a higher transmission power than normal is evenly distributed among the different transceivers, in which case no overheating occurs.

The example above only discloses one possibility out of many to distribute heat build-up among different transmitters. The alternation can be carried out in the described manner for each time slot, or, the time slot can be alternated when a certain number of time slots has been transmitted at a transmission power higher than normal via one transceiver. The alternation can also be carried out frame by frame, for example. It is essential that the

transmission of the time slots requiring transmission power higher than normal is alternated between different transceivers. The transceiver can thus be prevented from becoming overheated.

In the example of Figure 6, those time slots that are transmitted at a normal transmission power - in the place of which are transmitted time slots of the first time slot 600A, i.e. time slots 2 and 6 of the second frame 600B at a frequency f2, time slots 1 and 5 of the third frame 600C at a frequency f3, and time slots 0 and 4 of the fourth time slot 600D at a frequency f4 - are transmitted using the free capacity of the first transmitter 500A, i.e. the time slots 0, 1, 2, 3, 4, 5 and 6. This is a possibility to implement the alternation. Another possibility is not to transmit those time slots at all, but this would result in losing the capacity.

The invention can be implemented such that the base station system 126 comprises at least two transceivers 114, the control part 118, 124 for controlling the operation of the transceiver 114, and the switching field 120 for connecting the time slots to the transceivers 114. The control part 118, 124 defines certain transmission powers as a normal transmission power, and the control part 118, 124 is arranged to determine for each time slot the transmission power to be used. Furthermore, the control part 118, 124 is arranged to direct the switching field 120 to place the time slots transmitted at a transmission power higher than normal to be transmitted alternately, using at least two different transceivers 114 in order to minimize heat build-up in the transceivers 114.

A further requirement for the invention is that the transceiver 114 can be directed to a desired frequency applying the same principle described above in connection with synthesizer hopping, in other words it is required that the synthesizer 412 and the transmitter 420 can be directed to different frequencies in order to transmit each time slot at the desired frequency.

The invention is preferably implemented by software, whereby the invention requires functions in the software located in the control unit 124 of the base station controller 102, in the software located in the control unit 118 of the base station 100, and possibly also in the software located in the control unit 214 of the single transceiver 114.

Although the invention has been described above with reference to the example in accordance with the accompanying drawings, it is obvious that

the invention is not restricted thereto but it can be modified in many ways within the scope of the inventive idea disclosed in the attached claims.

CLAIMS

1. A method of transmitting time slots in a base station system, the method comprising the steps of:

- 5 defining (702) certain transmission powers as a normal transmission power;
determining (704) for each time slot the transmission power to be used;

characterized by transmitting time slots to be transmitted at a transmission power higher than normal alternately, using at least two different transceivers in order to minimize heat build-up in the transceivers.

10

2. A method as claimed in claim 1, **characterized** by placing a control channel in the time slot to be transmitted at a higher transmission power than normal.

3. A method as claimed in claim 1, **characterized** by placing a packet switched channel in the time slot to be transmitted at a higher transmission power than normal.

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4. A method as claimed in claim 3, **characterized** by the packet switched channel being a GPRS packet data traffic channel.

5. A method as claimed in claim 1, **characterized** by placing a high-speed data channel in the time slot to be transmitted at a higher transmission power than normal.

20

6. A method as claimed in claim 5, **characterized** by the high-speed data channel being an EDGE-modulated traffic channel.

7. A method as claimed in claim 5, **characterized** by the high-speed data channel being an EDGE-modulated GPRS packet data traffic channel.

25

8. A method as claimed in claim 1, **characterized** by transmitting the time slots to be transmitted at a higher transmission power than normal alternately, using at least two different antennas.

9. A method as claimed in claim 1, **characterized** by transmitting time slots to be transmitted at a normal transmission power using frequency hopping.

30

10. A base station system comprising at least two transceivers (114);

a control part (118, 124) for controlling the operation of the transceivers (114);

a switching field (120) for connecting time slots to the transceivers (114);

5 certain transmission powers being defined as a normal transmission power in the control part (118, 124);

the control part (118, 124) being arranged to determine for each time slot a transmission power to be used.

characterized in that the control part (118, 124) is arranged
10 to direct the switching field (120) to place time slots to be transmitted at a transmission power higher than normal to be transmitted alternately, using two different transceivers (114) in order to minimize heat build-up in the transceivers (114).

11. A base station system as claimed in claim 10, **characterized** in that the control part (118, 124) is arranged to place a control
15 channel in the time slot to be transmitted at a higher transmission power than normal.

12. A base station system as claimed in claim 10, **characterized** in that the control part (118, 124) is arranged to place a packet
20 switched channel in the time slot to be transmitted at a higher transmission power than normal.

13. A base station system as claimed in claim 12, **characterized** in that the packet switched channel is a GPRS packet data traffic
channel.

25 14. A base station system as claimed in claim 10, **characterized** in that the control part (118, 124) is arranged to place a high-speed data channel in the time slot to be transmitted at a higher transmission power than normal.

15. A base station system as claimed in claim 14, **characterized** in that the high-speed data channel is an EDGE-modulated traffic
30 channel.

16. A base station system as claimed in claim 14, **characterized** in that the high-speed data channel is an EDGE-modulated GPRS
packet data traffic channel.

35 17. A base station system as claimed in claim 10, **characterized** in that the base station system is arranged to transmit the time

slots to be transmitted at a higher transmission power than normal alternately, using at least two different antennas (112A, 112B).

18. A base station system as claimed in claim 10, **characterized** in that the base station system is arranged to transmit time slots to
5 be transmitted at a normal transmission power using frequency hopping.

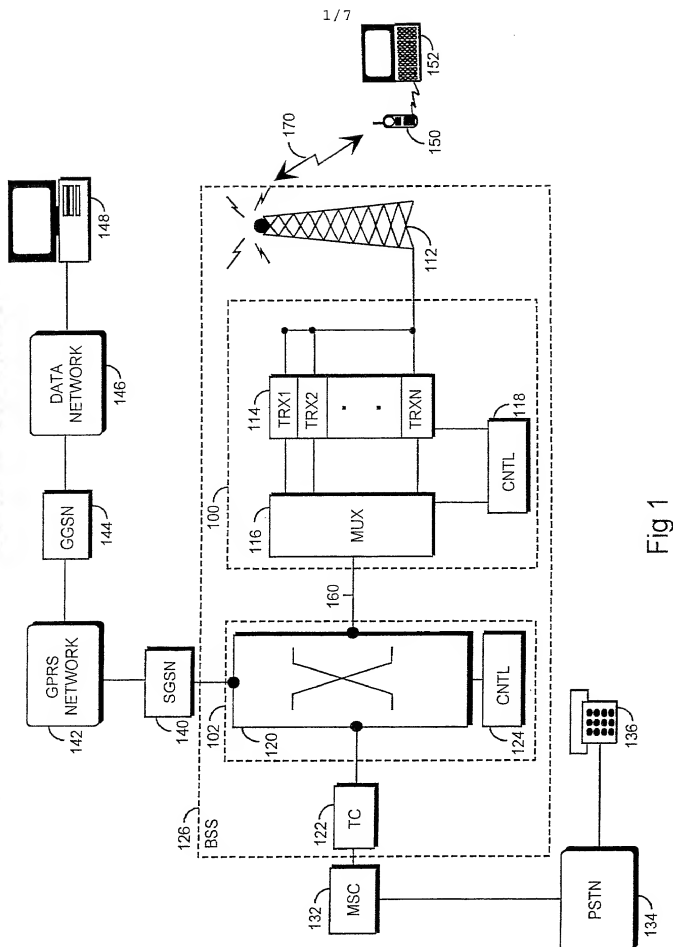


Fig 1

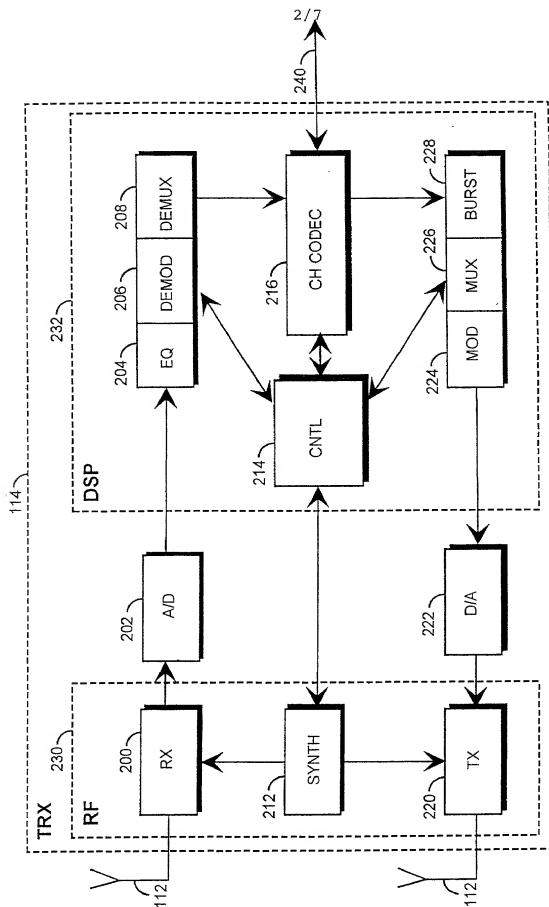
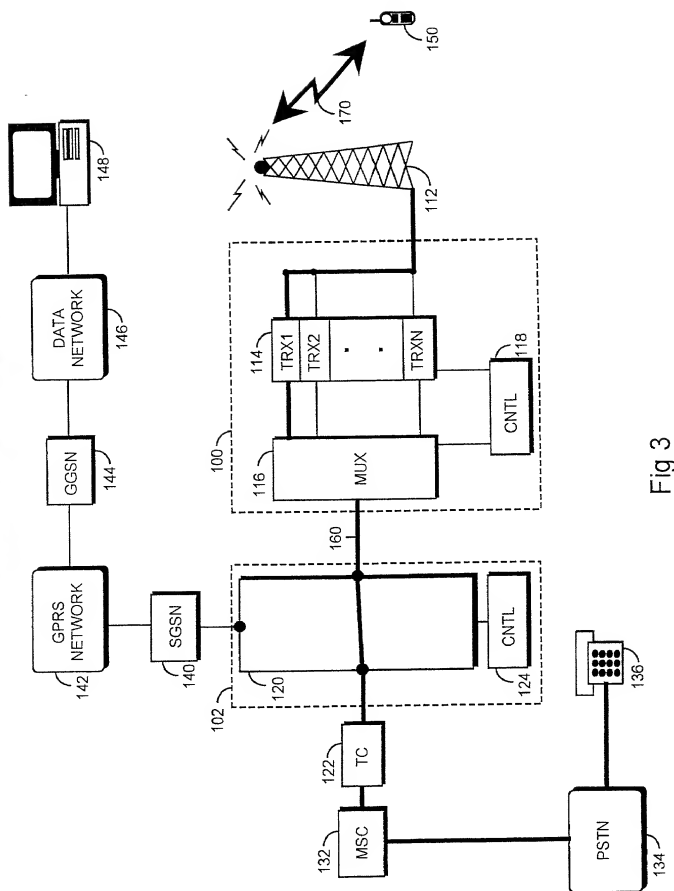


Fig 2



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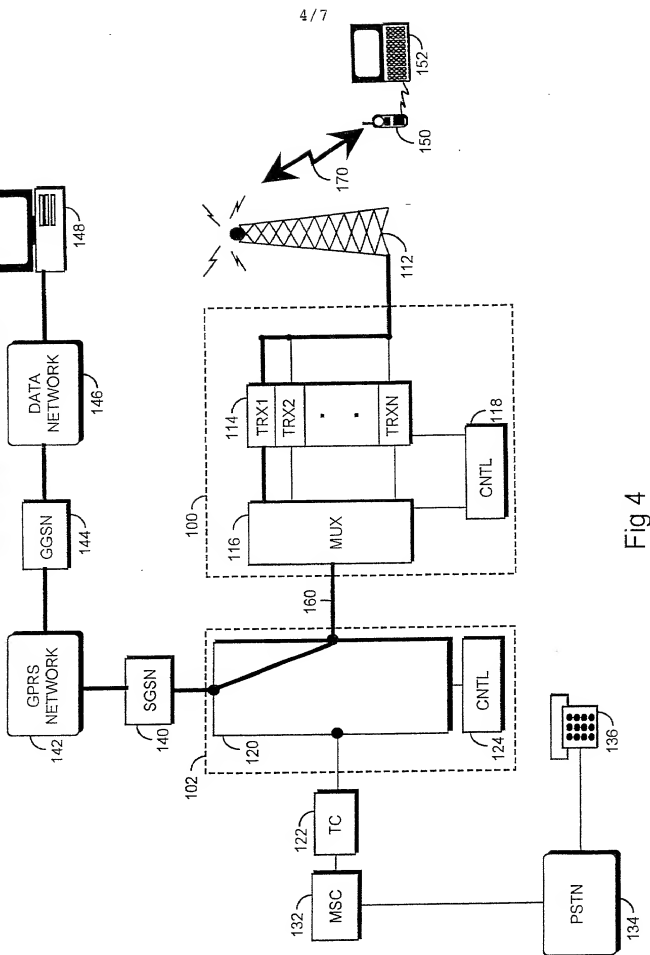


Fig 4

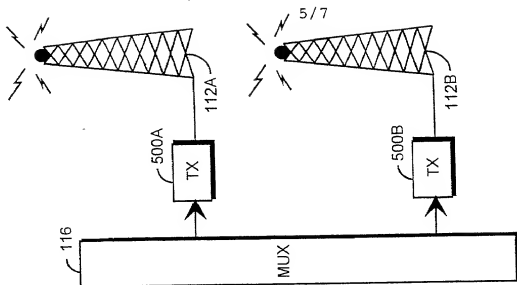


Fig 5B

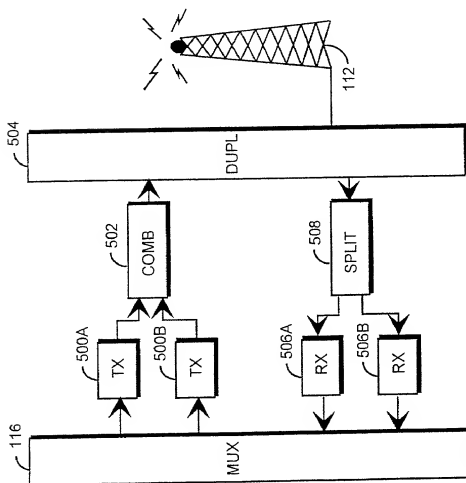


Fig 5A

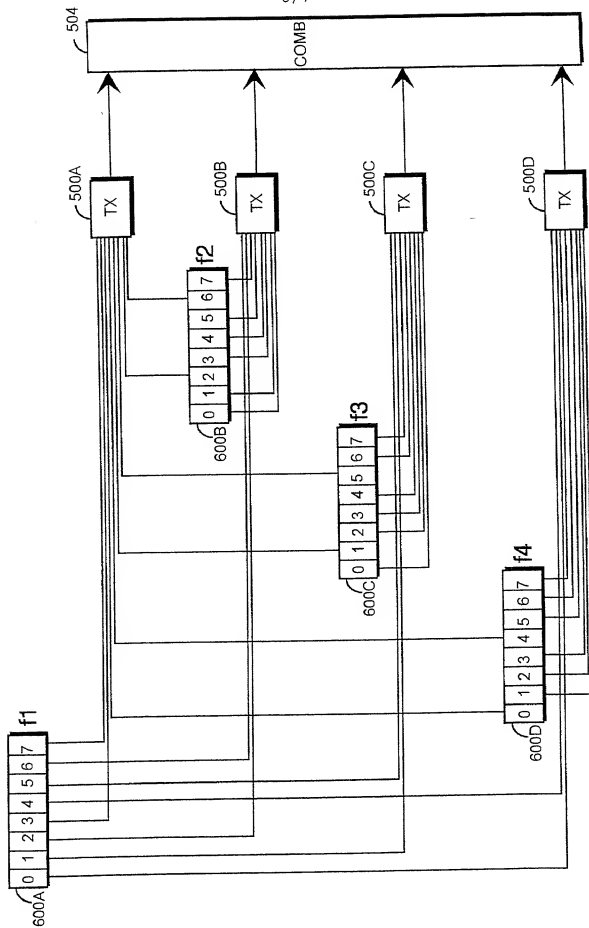


Fig 6

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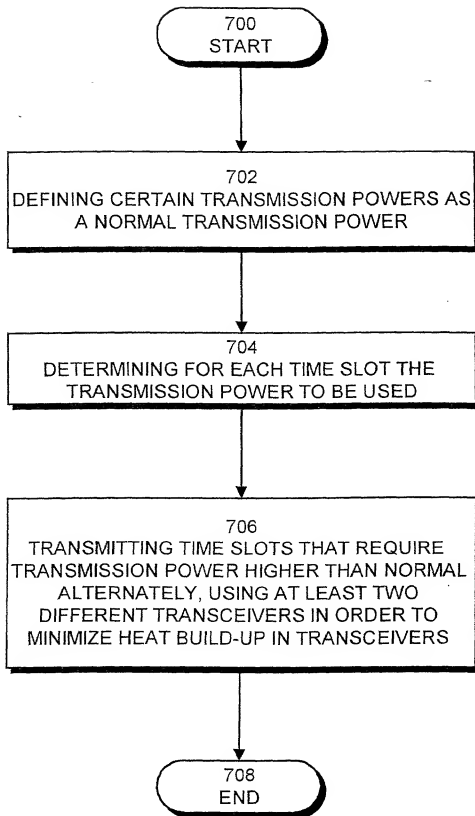


Fig 7

FOR UTILITY/DESIGN
CIP/PCT NATIONAL/PLANT
ORIGINAL/SUBSTITUTE/SUPPLEMENTAL
DECLARATIONS

RULE 63 (37 C.F.R. 1.63)
DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION

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FORM

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the **INVENTION ENTITLED**

Method of sending time slots in base station system and such a system

the specification of which (CHECK applicable BOX(ES))

X ☐ A. ☐ is attached hereto.
BOX(ES) ☒ B. ☐ was filed on _____ as U.S. Application No. _____
☒ C. ☐ was filed on _____ as PCT International Application No. PCT/ FI99 / 00500 on 9 June 1999

and (if applicable to U.S. or PCT application) was amended on _____
I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose all information known to me to be material to patentability as defined in 37 C.F.R. 1.56. I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International Application which designated at least one other country than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT International Application, filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which priority is claimed, or (2) if no priority claimed, before the filing date of this application:

PRIOR FOREIGN APPLICATION(S)

Number	Country	Day/MONTH/Year Filed	Date first Laid-open or Published	Date Patented or Granted	Priority Claimed Yes No
981372	Finland	12 June 1998			X

I hereby claim domestic priority benefit under 35 U.S.C. 119(e) or 120 and 365(c) of the indicated United States applications listed below and PCT international applications listed above or below and, if this is a continuation-in-part (CIP) application, insofar as the subject matter disclosed and claimed in this application is in addition to that disclosed in such prior applications, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in 37 C.F.R. 1.56 which became available between the filing date of each such prior application and the national or PCT international filing date of this application:

PRIOR U.S. PROVISIONAL, NONPROVISIONAL AND/OR PCT APPLICATION(S)

Application No. (series code/serial no.)	Day/MONTH/Year Filed	Status pending, abandoned, patented	Priority Claimed Yes No

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint Pillsbury Madison & Suto LLP, Intellectual Property Group, 1100 New York Avenue, N.W., Ninth Floor, East Tower, Washington, D.C. 20005-3918, telephone number (202) 861-3000 (to whom all communications are to be directed), and the below-named persons (of the same address) individually and collectively my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent, and I hereby authorize them to delete names/numbers below of persons no longer with their firm and to act and rely on instructions from and communicate directly with the person/assigned/attorney/firm/organization who/which first sends/send this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct the above firm and/or a below attorney in writing to the contrary.

Paul N. Kokulis	16773	Dale S. Lazar	28872	Mark G. Paulson	30793	Michael R. Dzwonczyk	36787
Raymond F. Lippitt	17519	Paul E. White, Jr.	32011	Stephen C. Glazier	31361	W. Patrick Bengtsson	32456
G. Lloyd Knight	17698	Glenn J. Perry	28458	Paul F. McQuade	31542	Jack S. Barufka	37087
Carl G. Love	18781	Kendrew H. Colton	30368	Ruth N. Morduch	31044	Adam R. Hess	41835
Kevin E. Joyce	20508	G. Paul Edgell	24238	Richard H. Zaitlen	27248		
George M. Sillia	18221	Lynn E. Eccleston	35881	Roger R. Wise	31204		
Donald J. Bird	25323	Timothy J. Klima	34852	Jay M. Finkelstein	21082		
Peter W. Gowdrey	25872	David A. Jakopin	32995	Anita M. Kirkpatrick	32617		

(1) INVENTOR'S SIGNATURE:

Date: 5.1.00

First		Middle Initial		Family Name	
Kari		Kontio		Finland	
City		State/Foreign Country		Country of Citizenship	
Kontio		Finland		Finland	
Post Office Address					
(include Zip Code)					
Kukkulantie 15, FIN-90910 Kontio, Finland					

(2) INVENTOR'S SIGNATURE:

Date:

First		Middle Initial		Family Name	
City		State/Foreign Country		Country of Citizenship	
Post Office Address					
(include Zip Code)					

(FOR ADDITIONAL INVENTORS, check box ☐ to attach PAT 116-2 same information for each re signature, name, date, citizenship, residence and address.)